

Research achievement

Directorate of Seed Research made significant achievements during 2013-14 by conducting basic, applied, strategic and anticipatory research in seed science and technology and in effective coordination and monitoring of nationwide network projects, as envisaged in its mandate. During the current year breeder, seed production under AICRP-NSP (Crops) amounted to 95011.59 quintals in addition to 6.30 lakh quintals of quality seed production of field crops under the project 'Seed production in agricultural crops.

Directorate, with the 22 number of scientists has started research work with 18 in-house research projects. With the limited infrastructure and small farm, the directorate has produced 568.40 quintals quality seeds in rice, 1268.50 quintals of wheat, 35.86 quintal of pulses, 3.50 quintal of mustard and 14.75 quintal barley including the seed produced under revolving fund scheme. Those seeds were processed in directorate's own processing unit and sold to the farmers and other Government organization in the locality to popularize quality seeds in bringing farm prosperity. Apart from this DSR has also generated resource of more than Rs. 55.0 lakhs from the sale of quality seeds.

Field and laboratory experiments conducted at the Directorate during the year generated invaluable scientific information and development of user-friendly agro-techniques. Identification of suitable varieties of field crops for the region, nutrient management for recovery of high quality produce micro-nutrient dose for rice and wheat, fine tuning of seed production technologies for hybrid rice under eastern UP conditions, priming and coating of seed for enhancing seed germination, initial vigour and growth, deployment of molecular tools and techniques to ascertain genetic purity of varieties, QTL mapping for seed vigour and bruchid resistance and optimum seedling age and planting geometry for rice cultivation through SRI method are a few to name. In addition, survey to identify important seed borne diseases and storage pests in major crops and study on insecticidal resistance led to development of prophylactic and control measures to the avert disease and insect problems. The salient research achievements during 2013-14 in DSR are as under.

- Molecular characterization of CSHH 198 cotton hybrids along with their parents was done using breeder seed to assess the genetic purity by using microsatellite SSR marker at genomic level. Out of sixty cotton SSR markers analyzed, 15 markers were found to produce polymorphism ranging 20-33%, amplifying a total of 29 alleles, with an average of ± 1.9 allelic variants per SSR locus. Most of the bands are found to be monomorphic across the genotypes tested, indicating substantial homogeneity in respect to the cotton genome.

- Three SSR markers showed amplification of an allele, which was very specific and unique to a particular parental line and not amplified in any other cotton parental line or hybrid tested. The dendrogram generated using the data, also confirmed close kinship among the hybrid and their parents while both were found to be grouped separately with each other. It also showed that the hybrids are near or having similar distance from both the parents and indicate true blend of both the parents.
- Effect of insecticidal seed treatment on seed viability during storage under ambient condition” was evaluated and all the treatments failed to maintain insect damage percentage below the IMSCS except emamectin benzoate (Insect damage-0.45%).
- Genetic purity assessment of DRRH2 rice hybrid and its A and R line using informative SSR markers is completed.
- Prepared two project proposal drafts entitled “Identification of seed production zones and popularization of new hybrids/varieties for enhancing productivity in selected field crops in eastern India” and Maintenance Breeding in Quality Seed Production”
- Seed priming of one year old pigeon pea seeds with GA3 @ 100 ppm and KNO3 @ 0.2%
- concentration for 12 h significantly enhanced the seed quality parameters like germination, seedling length, dry weight and vigour indices over unprimed control.
- Primary analysis of survey data recorded in 2013-14 in Ghazipur district of Uttar Pradesh showed that cost of cultivation for certified seed production of wheat was Rs. 31,900/- per hectare. Human labour constitutes major share (29.78 %) followed by machine labour (26.65 %), manures and fertilizers (14.11 %), irrigation (10.97 %), seed (9.40 %), plant protection chemicals (4.39 %), seed certification and other charges (4.70 %). Gross return in certified seed production of wheat was Rs. 65200/- and net return was Rs. 33,300/- per hectare. The BC ratio is 2.04.
- Bacterial isolates of healthy rice rhizosphere have been isolated for evaluation of seed borne disease management and seed quality enhancement of rice.
- Evaluated the Phosphate solubilization traits of isolated bacterial cultures and one isolate was found to have the phosphate solubilization activities.
- New packaging material “insecticide impregnated laminated bags” could able to maintain the insect infestation below 0.5% up to 04 month of storage under ambient condition.
- Maize seed coated with Flowable thiram (Royal flow 40SC) @ 2.4 ml/kg showed least deterioration in seed quality parameters with HDPE interwoven non laminated bags than the gunny bags after 02 month of storage.
- Evaluated the IAA production traits of isolated bacterial cultures for seed quality enhancement of rice and chickpea.

- Base-line survey of ten farmers has been made in Semari Jamalpur village of Mau district under Seed Village Scheme.
- Seed sectioning for seeds of *Cenchrus ciliaris*, *Lasiurus indicus*, *Panicum maximum* and *Brachiaria spp* is being carried out through microtomy methods for easier evaluation of seed viability status.
- Chickpea seeds primed with GA3 @ 100 ppm concentration showed early germination over unprimed seed.
- Insecticides namely emamectin benzoate and spinosad were found effective to restrict the insect damage below IMSCS (0.5%) in wheat seed after 6 months of storage.
- Artificially aged seed of hybrid paddy (KRH 2) and hybrid maize (Hema) showed deterioration in seed quality parameters with increasing ageing period and increasing storage period.
- Primers were designed for linked marker with seed vigour trait QTLs (Earlier identified, which includes minor QTLs and major QTLs of seed vigour traits).
- Evaluated the antagonistic effect of isolated bacterial cultures on *Macrophomina phaseolina* causing root rot of chickpea using dual culture technique and three isolates were found effective against *Macrophomina phaseolina*.
- Hybrid maize seed (HQPM-1) coated with Vitavax 200 (Corboxin 37.5% + Thiram 37.5%) @2.0 g/kg seed enhanced the seed germination and maintains the seed quality parameters up to 04 month of storage over uncoated control.
- Evaluated the antagonistic effect of isolated bacterial cultures on *Fusarium oxysporum* f.sp. *ciceri* causing wilt of chickpea using dual culture technique and five isolates were found effective against *Fusarium oxysporum* f.sp. *ciceri*.
- Emamectin benzoate was found effective to restrict the insect damage below IMSCS (0.5%) in wheat seeds after 240 days of storage under ambient condition.
- Evaluated the antagonistic effect of isolated bacterial cultures on *Ustilaginoidea virens* causing False smut of rice using dual culture technique and 8 isolates were found effective against *Ustilaginoidea virens*.
- Under storage condition to maintain the seed quality parameters in maize seeds, coating of seed with Flowable Thiram (Royal Flo 40 SC)@2.4 ml/kg seed was found most effective followed by Vitavax 200 (Containing Thiram 37.5% and Carboxyl 37.5%) @ 2 g/kg seed up to 4 month of storage period. Among the packaging material, HDPE bag was better than Gunny bag.
- Under Seed Village Scheme, farmer's trainings regarding seed production Technologies in rabi crops were conducted at DSR, Mau and other places on different dates and large number of farmers participated and benefitted.
- Biochemical characterization test has been done for 15 isolated bacterial cultures having antagonistic effect on fungal pathogens.

- Effect of insecticidal seed treatment on seed viability during storage under ambient condition was studied and Spinosad and emamectin benzoate was found to produce minimum insect damage in wheat seed after 9 months of storage.
- Under maintenance breeding 20 q. breeder seed of 4 rice varieties namely IR 36, IR 64, BPT 5204 and MTU 7029 were produced as per the allocated target at DSR Farm Mau.

During the year 2013-14, in addition to in-house research projects, activities of Directorate of Seed Research was concerned mainly towards coordination and monitoring of following network projects countrywide.

1. AICRP – National Seed Project (Crops)
2. Seed production in agricultural crops

Project wise salient findings/ achievements

AICRP-National Seed Project (Crops)

Breeder Seed Production

Progress of breeder seed production during 2012-13 was touching a production level of 95011.59q. However slight shortfall in few crops was observed due to climate vagaries in referred year

Seed Technology Research

I. Seed Production and Certification

a. Integrated approach for maximization of seed yield

Rice

In case of JRH 5 hybrid rice seed production, the alternate method of planting pollen parent with application of recommended dose of NPK along with micronutrients Boron + Sulphur + Zinc was the best treatment combination in increasing the seed yield with highest C:B ratio of 1:1.60.

The hybrid seed yield of CORH 4 was significantly highest (10.32 q/ha) in case of mixed planting of male parent (CB 174R) and applications of micronutrient Boron @ 0.02% spray at panicle initiation stage.

In case of KRH-4 hybrid seed production, application of 125:75:75 kg NPK/ha and foliar application of Boron @0.5% at the time of panicle exertion has significantly increased (8%) the seed yield at TNAU, Coimbatore.

At KAU, Pattambi, irrespective of hybrids (DRRH 2 and DRRH 3) alternate/ mixed planting of staggered pollen parent maximized seed set in hybrids.

Wheat

At Kanpur, plain sowing along with application of 1.25 × RDF (recommended dose of fertilizer) and 5 kg Zn / ha exhibited maximum seed yield (69.76 q/ha), quality, seed recovery percentage and benefit cost ratio of 2.88. In case of PBW 502 (Faizabad), Ridge planting with 150: 75: 50 NPK/ ha and 10Kg/ha zinc sulphate as basal enhanced seed yield and C:B ratio to 1:1.68. At Hisar, in cv WH-102, the ridge sowing method increased seed yield by 3.49 % over conventional sowing method. Mn and Zn enhanced yield by 3.19 to 5.32 percent and 8.39 to 9.09 per cent respectively. At Dharwad, in GW-322, ridge method of sowing and application of 1.50 x RDF showed significantly higher plant growth parameters and seed yield (47.2q/ha).

Groundnut

At ANGRAU, Hyderabad, var. Kadiri 9, application of FYM @ 7.5 t/ha + RDNPK + gypsum @ 500 kg/ha at pegging recorded higher sound mature kernels (74.90%), pod yield (45.53 q/ha) and germination (92%). At OUAT, Bhubaneswar, in TAG 24, application of FYM 7.5 t/ha + RDNPK of 20:40:40 + Borax @ 15 kg/ha recorded the highest seed yield (12.49 q/ha) with 13.8 and 5.84% increase over RDNPK and FYM + RDNPK application respectively with increased Shelling %. Gypsum application @ 300 kg/ha the highest seed yield of 12.53 q/ha which was 17.1, 11.5 and 11.1% higher than control, 2% urea spray at 30 DAS and 2% urea spray at 30 and 60 DAS, respectively.

Sunflower

At ANGRAU, Hyderabad, in APSH 66, soil application of sulphur @ 10 kg/ha and soil application of borax @ 1 kg/ha increased yield by 39% (11.27 q ha⁻¹) and 36.33% (10.65 q ha⁻¹) over control (6.78 qha⁻¹). Soil application of sulphur @ 10 kg/ha increased germination, root length, shoot length, seedling length and seedling vigour index I by 34, 41.17, 3, 25.34, 68.53% respectively against control. At UAS, Bangalore, in KBSH-53, highest seed yield (8.2 q/ha) was recorded by application of 20% >RDF (75:90:75 NPK kg/ha) + zinc sulphate @ 10 kg/ha (soil application) + boron @ 0.2% (Foliar spray at ray floret initiation stage) over control (7.3 q/ha) with recommended RDF without micronutrient application.

Maize

In maize hybrid Hema (NAI-137 x MAI-105) at Bangalore, application of 40% >RDF (210: 105:56 NPK kg/ha) + ZnSO₄ @10 kg/ha in the form of 40% N basal + 30% N at 8 leaf stage + 30% N at tasseling increased seed yield (25.05 q/ha) by 25.50% over the recommended NPK kg/ha (150:75:40 NPK kg/ha) + ZnSo₄ @10kg/ha in the form of 40% N basal + 60% N at tasseling.

Soybean

At Rahuri, 1000 seed weight (144.7 g), seed yield (37.20 q/ha), number of pods per plant (73) and seed quality parameters viz., germination (91.00%) and dry

matter content (0.57 g), root shoot length (30.10 cm) and vigour index II (50.98) were significantly superior in the ridge sowing with application of 150% dose than recommended fertilizer dose and application of 5 kg chelated Zn/ha over the other treatment combinations with highest B:C ratio (2.45).

Ridge sowing + recommended DAP + soil application of $ZnSO_4$ @ 30 kg/ha + foliar spray @ 0.5% at 52 and 60 DAS was found significantly superior for number of pods/plants (84), seed yield/ha (29.61 q), seed recovery (96%) and vigour index (84.93) with a C:B ratio of 1:2.7 over other treatment combinations at Akola centre.

In UAS, Raichur, 40:80:25 NPK kg/ha + S-40kg + Zn -5kg increased seed yield (1636 kg/ha) by 20% over control (1359kg/ha). Ridges furrow method increased germination (77%), seedling length (20.8 cm), seedling vigour index (1568) over flat bed method.

At JNKVV, Jabalpur, the treatment 150% NPK resulted in higher processed seed yield (1196kg/ha), 100 seed weight (7.88), seed recovery (85%), germination (84%) and vigour index (2550). Application of NPK+ S + Zn+ B+ Mo increased processed seed yield (1298kg/ha), 100 seed weight (8.04g), seed recovery (87%), germination percent (86%) and vigour index (2671). Ridge and furrow cultivation had highest C:B ratio of 1:2.

Mustard

At Kanpur, in cv Urvashi, Application of 7.5 kg Zn ha⁻¹ and Seed treatment with Carbendazim @ 2 g/kg of seed showed significantly highest seed yield (29.17 q ha⁻¹) with 98.9% of seed recovery and Benefit: Cost of 2.15:1.

In Durgapura, application of RDNPK + Gypsum + Fe ($FeSO_4$ @ 25 kg/ha) + Zn ($ZnSO_4$ @ 25 kg/ha) recorded highest Seed yield (35% more), 1000-seed weight (6.25 g) and seedling vigour index (3711) compared to the RDNPK application.

Berseem

Normal sowing (15th October), Cutting at 10 days before normal last cut (75 DAS) and nutritional spray (KNO_3 @ 2% and Borax @ 100 ppm) at the reproductive stage resulted in higher seed yield of 1.24 q/ha at Rahuri centre.

In Jabalpur, second date of sowing (15th January), cutting at 10 days after normal last cut and spray of KNO_3 @ 2 % was found to be significantly superior for increase in seed yield.

At Pantnagar, under both normal and late sown conditions, 10 days before last cut+ Borax spray @ 100 ppm at reproductive stage is equally effective for obtaining more yields in both genotypes (Wardan and Jawahar Berseem 1). The borax application @ 100 ppm at reproductive stage just 10 days before last cut as well as 10 days after last cut is found very effective for getting more seed yield followed by spray of KNO_3 @ 2% at reproductive stage just 10 days before last cut.

Cluster bean

At Coimbatore, in Pusa Navbhar, 45 x 20 cm spacing and sowing on July 1st resulted in better growth parameters, seed yield and seed quality characters. At Jodhpur, in cv. RGC 936, incidence of diseases like, wilt, blight and powdery mildew and insect pests, leaf cutter, white fly and aphids were observed more in 10th and 20th July sowing compared to sowing done on 1st July. At Durgapura, in RC 1038, Plant height and seedling length were affected by sub effects i.e. different row spacings. Higher seed yield (13.31 q/ha) was observed in crop geometry 30 x 30 cm sown on 01.07.2013. Seed yield in 1 July (12.79 q/ha) and 11 July (11.83 q/ha) sowing were at par being significantly superior to the late sowing on 21.07.2013 (7.44 q/ha).

b. Pilot project on alternative area for hybrid seed production of major crop in different seasons

Crop	Hybrid	New Areas	Cost: Benefit	Seed Yield (q/ha)
Rice	JRH 5	Balaghat, Madhya Pradesh	1:1.86	
	KRH 4	Sira , Karnataka	1:1.13	11.92
		T. Narasipura , Karnataka	1:1.12	10.58
	NDRH 2	Faizabad, Chhattisgarh plains		
	PSD 3	Areas outside of Pantnagar, Uttarakhand		
Pigeon pea	ICPH 2671	Seoni, Madhya Pradesh	1:1.4	4.2
	AKPHM-11303	ZARS, Yeotmal, Maharashtra	1:1.56	6.43
Pearl millet	RHB-173 (ICMA 93333A x RIB 192)	Bharatpur, Rajasthan		
Maize	Hema	Sira, Karnataka	1:1.75	22.50
		Hiriyur taluk, Karnataka	1:1.72	21.70
		Siraguppa, Karnataka	1:1.70	21.25
	HQPM 1	Pathera village, Karnal dist, Andhra Pradesh	1:1.73	
Castor	GAUCH-1 and GCH-4	Surendranagar dist, Gujarat Gadwal in Mahboobnagar district, Reddipalli area of Ananthapur, Nandyal and Banaganapally, Kurnool dist, Andhra Pradesh	1:0.71	

c. Studies on cutting management for seed yield and its quality in *Cenchrus ciliaris*

The genotypes CAZRI 2221 and CAZRI 2178 are the better genotypes for seed production and its related traits, and also for fodder production. Among the genotypes, CAZRI 2178 recorded maximum pure seed yield (82.8 kg/ha) whereas, CAZRI 2221 recorded maximum green fodder yield (12603 kg/ha) and dry matter production (4025 kg/ha). Uncut crop had maximum pure seed yield (102.4 kg/ha) i.e. 43% higher seed yield and 18% more dry matter than foliage cutting at 45 days. Overall foliage cutting reduced the seed yield, hence not advisable for seed production in *C. ciliaris* under hot arid climate.

d. Evaluation of SRI for enhanced seed yield and quality of hybrid rice

In case of DRRH 3 hybrid, SRI method resulted in yield improvement of 18.04% over the conventional method at ANGRAU, Hyderabad and DRR, Hyderabad due to increase in ear bearing tillers per hill, spikelet fertility and root volume. At PAJANCOA&RI, Karaikal, CORH 4 performed better and produced 37.96% higher seed yield than DRRH 2 with the improvement in yield contributing components viz., number of effective tillers/hill, number of filled grains/panicle, percentage spikelet fertility and single plant seed yield. Irrespective of the hybrids studied, 28% higher seed yield was recorded with SRI method. At Jorhat, seed yield of Hybrid Indira Sona was found superior in SRI method (6.56 q/ha) over conventional method (5.40 q/ha).

e. Hybrid seed production in Brinjal and Tomato under protected conditions

At UAS, Dharwad, in case of tomato- Pusa hybrid 2, higher seed yield of 187.1kg/ha was recorded under shade house condition with higher seed quality parameters at spacing of 60 x 60 cm compared to open field conditions. In brinjal hybrid PH9 at number of fruits per plant (3.58) and fruit set (19.90%) were higher under shade house condition whereas seed weight per fruit was maximum under open field condition. 60 cm x 75 cm spacing recorded maximum seed yield under both conditions with better seed quality recorded under shade house condition.

Seed production of Brinjal Hybrids namely, Pusa Hybrid 5, Pusa Hybrid 6 and Pusa Hybrid 9, under net house condition resulted in profitable Cost benefit ratio of 1:1.9 with better seed quality at IARI, New Delhi.

f. Optimization of seed production technology in mungbean for maximizing seed yield

In mungbean, var. NDM 1, sown between 15th July and 1st August, spacing of 30 x 10 cm and treatment of seed with Rhizobium and Phosphate Solubilizing Bacteria + RDF as basal dose + Borax spray (100 ppm) was found optimum for maximizing seed yield at Faizabad and Jabalpur.

g. Standardization of seed production of multi-cut forage sorghum hybrids under north Indian conditions

At Pantnagar, Hybrid H 2 (CSH 24MF) produced significantly higher yield/plant and higher seed quality than Hybrid H 1 (CSH 20MF) because of less difference (3 days) in time taken for 5% flowering in male and female parent of H 2 hybrid as compared to H 1 hybrid parents (18 days). Because of greater difference in male and female parent flowering in H 1 seed set per cent was very poor. It is, therefore, suggested that staggered planting of male parent be also included in the experiment in order to achieve nicking and synchronization in flowering between male and female parent for better seed set and seed quality. Among different dates of planting treatments, 10th June and 10th July planted crop recorded highest and lowest seed yield/plant, respectively, with no significant influence on seed quality parameters.

h. Standardization of alternative planting windows *vis-s-vis* climate change

Centre and crop	Planting window	Observation/Highlights
Rahuri Pearl millet (Shanti)	August onwards or 15 th October to 15 th December	70%- Seed setting and disease viz., <i>Helmenthosporium</i> leaf spot, Ergot, <i>Alternaria</i> blight and Rust incidence (August sowing)
	January	80%- Seed setting
	February or 1 st June to 15 th July	100%- Seed setting with low disease and insect pest incidence (June –July sowing)
	March onwards	70-50%- Seed setting
	August and after February	Aphids, Thrips, hoppers and stem borer infestation
Bangalore Sunflower Parental lines of hybrid KBSH-44, KBSH-53	1 st March	Superior seed yield and yield attributing characters
	July and August	Higher incidence of diseases
	1 st May	Lower seed yield per plant and seed setting
	1 st June	Lowest seed setting
ANGRAU Sorghum (CSH14)	October	Early flowering, high pollen viability, cent per cent seed setting and highest seed yield
	November	Early flower initiation, lower seed setting

i. Pilot project on evaluation of rice genotypes for seedlings suitable for direct seeding

At ANRAU, Hyderabad and DRR, Hyderabad sowing with drum seeder had no significant impact on root characters at active tillering stage and grain yield. Among the varieties Rasi, Aditya and Krishnahamsa performed better with drum seeder and resulted in grain yield of 5.78 t/ha, 5.67 t/ha and 5.58 t/ha, respectively.

At Coimbatore, cultivars PHB 7, DRRH 2 and COI 50 registered higher root length in wet as well as in dry seeding. Root volume was higher in DRRH 2, PHB 71

and Aditya in both whereas vasumathi registered low volume in wet seeding. At Bangalore, seed yield and crop performance was better in 10hysic condition in all the 22 cultivars. Hybrid KRH-4 recorded the highest seed yield followed by cultivars MAS-26, KMP-175 and Rasi under aerobic condition and is more suited for the direct seeding. At Faizabad, the grain yield ranged from 28.4 q/ha (Rasi) to 45.5 q/ha (PHB 71). At Jorhat, all fifteen tested varieties differed significantly for all the characters with highest seed yield of 2852 kg/ha recorded by variety JR 16 and Manoharsali with highest (318) tillers/m².

4... **Seed Physiology, Storage and Testing**

- First count of germination showed significant positive correlation with field emergence and may be used as an index to assess the planting value of hybrid maize, cotton and paddy.
- Accelerated ageing for 96 hrs (hybrid maize), 48 & 72 hrs (hybrid cotton) and 96 hrs (hybrid paddy) showed high significant correlation with storage potential and may be used as an index of storability.
- Polymer coating @ 3ml/kg seed in combination with flowable thiram (2.4 ml/kg) or vitavex 200* @ 2g/kg seed (Thiram 37.5 % + Carboxyl 37.5 %) or polymer in combination with vitavex 200* were found at par in maintaining the seed quality of hybrid paddy and hybrid maize for one planting season.
- SSR markers (RM 19, RM 336, RM 204, RM 202) have been validated and revalidated for hybridity and genetic purity testing of paddy hybrid DRRH-2, DRRH-3 and KRH-4.
- SSR marker (ORS-878) has been identified to distinguish the parents of sunflower hybrid APSH-66 amplifying female parent at 220 bp and male at 235 bp.
- Exposure of seeds to Pulsed Electromagnetic Field (PEMF) @ 100 Hz significantly improves the seed quality as well as seed yield of mungbean, paddy and maize.
- A total of 105 demonstrations of hydro-priming technology were organized at farmer's field across the centres.
- Hydro-priming technology improves seed yields by 6-11.5% in different crops (Wheat, paddy, pearl millet, sorghum, mungbean, pigeon pea & chickpea).

4... **Seed Pathology**

- Bacterial Panicle Blight disease of rice (*Burkholderia glumae*) by GBPUA&T, Pantnagar, Uttarakhand; Viral disease caused by *Bean Common Mosaic* on cluster bean/ guar (*Cyamopsis tetragonoloba*) and false head smut

(*Ustilagoideae virens*) of maize from Anand (Gujarat) are reported as new emerging seed-borne diseases.

- *Burkholderia glumae* is found responsible for Bacterial Panicle Blight (BPB) disease in rice and also causes bacterial grain rot. The most susceptible period for floret infections is during panicle emergence and flowering. The infected seeds are poor in germination, give reduced grain weight and poor plant stand.
- The bacterium is isolated both from discoloured and even from healthy looking seed, collected from infected crop. The pathogen is readily seed-borne and is successfully isolated on King's B medium from infected seeds when incubated at 28°C for 48 h. The bacterium survives in seed from year to year.
- The fungus *A. porri* survives in infected seed, collected from infected umbels for >20 months under dry and cold conditions. However, the longevity of *A. porri*, in infected seeds, under ambient conditions is noticed only up to a period of 12 months.
- The seed treatment with both the bio agents (*T. harzianum* and *Ps. Fluorescens* @ 10g/kg of seed (1:1) are found effective in improving germination but did not manage the seed borne infection of *A. porri* in Onion crop.
- Heat treatment of onion bulbs at 35°C for 8 hours before planting helps in reducing the purple blotch infection.
- The seeds when treated with different concentration of biocontrol agents, *Trichoderma viride* and *Ps. Fluorescens*, the CFU/g seed decreased with the increase in storage period at ambient room temperature.
- Biocontrol agent *Ps. Fluorescence*, on artificial inoculation in tomato seedlings induce resistance against Alternaria blight infection.

IV. Seed Entomology

1. Studies on the effect of insecticidal seed treatment on seed viability during storage under ambient condition.

Newer insecticide molecules viz. emamectin benzoate 5 SG@ 2 ppm (40.0 mg/kg seed), spinosad 45 SC @ 2 ppm (4.4 mg/kg seed), indoxacarb 14.5 SC @ 2 ppm (13.8 mg/kg seed), rynaxypyr 20 SC @2ppm (0.01 ml/kg seed), chlorfenapyr 10 EC@2ppm (0.02 ml/kg seed), profenofos (Curacron 50 EC) @2ppm (0.004ml/kg seed), novaluron (Rimon 10 EC) @ 5ppm (0.05 ml/kg seed) were evaluated along with standard chemical (deltamethrin) against major storage insect-pests damaging cereals and pulse seeds. This experiment was modified last year and Profenofos was included.

All newer insecticides especially emamectin benzoate (Proclaim 5SG) @ 2 ppm (40.0 mg/kg seed), followed by spinosad (Tracer 45 SC) @ 2 ppm (4.4 mg/kg seed), rynaxypyr (Coragen 20 SC) @2ppm (0.01ml/kg seed), profenofos (Curacron 50 EC) @2ppm (0.004ml/kg seed), chlorfenapyr (Intrepid 10 EC) @2ppm (0.02ml/kg seed), indoxacarb (avaunt 14.5 SC) @ 2 ppm (13.8 mg/kg seed) and novaluron (Rimon 10 EC) @ 5ppm (0.05ml/kg seed) were found at par with deltamethrin (Decis 2.8 EC) @1.0 ppm and provided control of storage insects infesting wheat, pearl millet, and maize under different agro-climatic conditions up to three to six months.

2. Evaluation of packaging material and methodology to store seed in Coastal region

Paddy seeds treated with flubendiamide (Fame 480 SC) (4.2 mg/ kg seed), emamectin benzoate (Proclaim 5SG) @ 2 ppm (40.0 mg/kg seed), spinosad (Tracer 45 SC) @ 2 ppm (4.4 mg/kg seed), deltamethrin 2.8 EC (0.04ml /kg seed) were stored in three different types of packaging materials (Gunny bag, Super grain bags and HDPE bags) at Karaikal and Bhubaneswar centre.

Paddy seed treated with deltamethrin @ 1.0 ppm and spinosad @ 2 ppm and stored in moisture impervious bags like super grain bags maintained seed germination above IMSCS with appreciable control of insect infestation up to 12 months period at Karaikal.

3. Survey and evaluation of seed health status of farmers' saved seed with respect to insect infestation

Samples of farmers' saved seed were collected by all cooperating centres and evaluated for seed health status with special reference to insect infestation. Most of samples (76.3%) were having germination above IMSCS. In contrast, large proportion (about 36.9%) of farmers' seed samples were infested with storage pests and intensity of damaged seed usually varied from 0.1to10% while in some cases it had gone up to 32%.

4. Quality seed production through insect pollination

Bee pollination plays a major role in improving the quantity of seed produced in case of sunflower. Apart from seed yield, parameter like vigour and oil content improved substantially due to bee pollination. In case of pigeon pea other pollinators like leaf cutter bee, carpenter bee play major role in pollination.

5. Effect of carbon dioxide (CO₂) treatment on the control of storage insect pests and the seed quality attributes under ambient conditions.

Seed storage at 50% CO₂ treatment can provide complete protection against khapra beetle in wheat, groundnut beetle in groundnut and pulse

bruchid in green gram and chick pea without affecting seed quality up to 6-9 months storage. Thus, CO₂ can be a good alternative to use of chemical treatments including fumigants for preventing storage pests in wheat, groundnut, chickpea and green gram.

6. Demonstration of efficacy of CO₂ treatment for management of insect pests of stored seeds in large capacity storage bin.

Effectiveness of CO₂ treatment in 50L capacity containers for treating black gram seed has been successfully demonstrated at TNAU, Coimbatore. This clearly indicated that large scale would be equally effective in controlling storage pests.

7. Effect of interval of insecticidal application on storability of seed under ambient condition.

This experiment was conducted to evaluate integration effect of seed treatment as well as fabric treatments against infestation of major storage insect-pests damaging seeds.

Treatment schedules i.e. combination of seed treatment (emamectin benzoate 5SG @2ppm a.i.) and fabric treatment (emamectin benzoate 5SG@100ppm a.i.) at various centres have been developed for management of storage insects of seeds having better storage life (good storer) but prone to insect damage.

8. Effect of new packaging material (insecticide impregnated bags) on storability of seed under ambient condition.

Different types of insecticide impregnated bags like treated bag, no lamination, no liner; Treated bag, non treated lamination, non treated liner and treated bag, treated lamination, treated liner were tested along with untreated bag (same fabric i.e. PP Bag) and gunny bag (control).

Preliminary results showed that different types of insecticide impregnated bags are quite effective for management of storage pests. But storage of treated seed (seed treatment with emamectin benzoate @ 2ppm) in insecticide impregnated bags has shown better insect pest management.

V. Seed Processing

- The use of combine harvester at 500 rpm of drum speed is found most economical and effective for maintaining seed quality during harvesting and threshing of soybean. Similarly for minimum field losses and maximum seed quality use of combine harvester at 15 to 20 cm height of cutter bar from ground level was found effective and economical.

- The ODV seeds in paddy seed lot can be effectively removed to the acceptable limit by using specific gravity separator in addition to seed cleaner and grader.
- There is urgent need to modernize the seed processing plants in most of the places. The condition of the many seed processing plant is not encouraging. Nearly 80 % of the plants are single machined plants i.e. having seed cleaner cum grader only. Most of the plants do not have basic machinery like moisture meter, etc. In most of the plants specific gravity separator is not either available or not in use. The efficiency of the machines is not satisfactory and the percentage of the rejection is more than 20 % in major crops. In most of the plants there is no proper seed storage facilities and in most of the places the seed protection measures like fumigation are not followed properly.

Recommended sieve size for grading different category of seeds

Crop	Variety/cultivars	Screen size (mm)
Paddy	Fine grained: PKV HMT, PKV Khamang, JGL 387, Sonalika & Suvarna	1.4
	Coarse grain	1.6
Chickpea	Chaffa, Vijay, Vishal, ICCV 10 and G 12	5.0
	Bold seeded: Jaki, PKV Kabuli and G 5	5.5
Pigeon pea	C 11, ICPL 87119, AKT 8811 and BDN 2	3.6
Wheat & Barley		2.75
Sunflower hybrid KBSH 53		2.40 x 20 (S)
Maize hybrid Nithyashree		4.76 x20 (S)
Safflower		2.2
Soybean		3.6
Ragi		1.3

Awards and Publications

In reference to recognitions, scientists / cooperating centres received five awards / merit certificates for excellence in agricultural research and development activities, and published 98 research papers related to seed science and technology in national / international peer reviewed journals.

Extension activities

Imparting field level training and practical exposure to field staff and farmers engaged in seed production programme are being taken up by different centres. Several extension activities like exhibitions, kisan mela, kisan goshti, field day, demonstration have been conducted by several cooperating centres mentioned

below. In order to create the required scientific manpower and to enhance the expertise and skill of the existing scientific staff, the STR centres were entrusted with the task of conducting training programmes under human resource development (HRD). This would certainly boost the quality and quantity of the seed and would help to increase the seed replacement rate (SRR) in different crops.

Sl. No.	Centre	No. of training	Exhibition/Kisan Mela	Research paper	Awards
1	CCSHAU, Hisar	2	2	-	-
2	OUAT, Bhubaneswar	7	-	2	-
3	GBPUAT, Pantanagar	-	1	2	-
4	CSAUA&T, Kanpur	-	-	4	-
5	PDKV, Akola	15	5	3	-
6	JNKVV, Jabalpur	3	-	14	2
7	JAU, Jamnagar	1	1	-	-
8	RAU, Durgapura	5	-	4	-
9	TNAU, Coimbatore	3	-	14	2
10	ANGRAU, Hyderabad	6	-	55	-
11	CICR, Nagpur	1	-	-	-
12	DSR, Mau	10	03	-	1
	Total	53	12	98	5

Monitoring: Monitoring Teams for different zones (Northern, Eastern, Western, Central and South Zone) constituted during the last workshop have visited different centres and the observations made by different monitoring teams have been presented in Annexure I. Project Director has also monitored the progress of BSP and conduct of the STR research activities.

Seed Production in Agricultural Crops

During the year 2013-14, total production of quality seed including all classes was 630417.84 quintals against the target of 461530.84 quintals. Production comprises 91710.94 quintals of breeder seed, 135813.82 quintals of foundation seed, 162771.07 quintals of certified seeds, 168331.77 quintals of truthfully 15hysic15 seed and 71790.24 quintals of planting material of field crops. In addition, 84.75 lakhs planting material and 4.65 lakh tissue culture plantlets of field crops were produced against the targets of 94.05 and 1.32 lakhs.